CDM Smith

Memorandum

To: *Elizabeth Fagen, Mike Cirian (EPA, Region 8)*

From: *Lynn Woodbury*

Date: *March 8, 2013*

Subject: *Effect of using surface water for construction application and irrigation*

INTRODUCTION AND PURPOSE

Since 1999, the U.S. Environmental Protection Agency (EPA) has conducted sampling and cleanup activities at the Libby Asbestos Superfund Site (Site). Water is utilized at the Site as part of a variety of response activities, including dust suppression during construction, personal and equipment decontamination, watering lawns, and washing paved roads. Historically, water for use in these activities was collected from the Kootenai River at the City of Libby pump station located in Operable Unit 1 (OU1). In order to reduce truck traffic within OU1, the City of Libby abandoned this pump station requiring the EPA to identify an alternative water source location. As a result, sampling was conducted in 2011 and 2012 to support the identification of a new water source for use at the Site.

Site managers identified more than a dozen potential water source candidates for sampling. Because asbestos concentrations in water are influenced by flow variations, sampling was separated into two phases to ensure resulting data were representative of both low flow (Phase I) and high flow (Phase II) conditions. No Libby amphibole (LA) was detected in any water samples collected under low flow conditions (fall 2011). Under high flow conditions (spring 2012), average total[a] LA concentrations in water ranged from non-detect to 0.2 million fibers per liter (MFL) and average water concentrations based on LA structures longer than 10 micrometers (um)[b] ranged from non-detect to 0.007 MFL.

Since LA was detected in these water sources, per your request, we have prepared screening level calculations to evaluate the potential effect of using this water for construction application and irrigation (i.e., would use of this water increase LA levels in soil such that potential human exposures would be of concern). This technical memorandum summarizes the results of this evaluation.

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[a] Based on recorded structures longer than 0.5 micrometers (um) with an aspect ratio (length:width) of 3:1 or greater.
[b] This concentration metric is the basis of the drinking water maximum contaminant level (MCL).

CONSTRUCTION APPLICATION SCENARIO

There is no criterion that specifies the maximum concentration of asbestos in water that can be used for the purposes of construction application. Therefore, the potential effect of water use as a consequence of water application to soil during construction activities was evaluated by determining the potential difference in the resulting asbestos soil concentration, expressed as structures per gram (s/g. The basic equations utilized are as follows:

$$C_{soil,post} = C_{soil,pre} + (N_{added} / M_{soil})$$

where:

$C_{soil,\,post}$ = Concentration of total LA in soil after water application (s/g)
$C_{soil,\,pre}$ = Concentration of total LA in soil prior to water application (s/g)
N_{added} = Number of LA structures added to soil due to water application (s)
M_{soil} = Mass of soil to which water was applied (g)

For the purposes of these calculations, it was assumed that the initial soil concentration of LA ($C_{soil,pre}$) was about 5E+05 structures per gram (s/g). This assumption is based on average measured concentrations of total LA (by transmission electron microscopy [TEM] following preparation using the fluidized bed asbestos segregator [FBAS]) in borrow source materials and soil from locations that are not believed to be affected by anthropogenic sources. This soil concentration (5E+05 s/g) is approximately 0.014% by mass, as determined from an LA-specific regression derived from mass-based performance evaluation standards (Januch *et al.* 2013).

The number of LA structures added to the soil due to water application (N_{added}) is calculated as follows:

$$N_{added} = C_{water} \cdot WR \cdot CF_1 \cdot A$$

where:

N_{added} = Number of LA structures added to soil due to water application (s)
C_{water} = Concentration of total LA in water (s/L)
WR = Water application rate (gal/ft^2)
CF_1 = Conversion factor (3.8; gal to L)
A = Soil application area (ft^2)

As noted above, average measured total LA water concentrations in the water source candidates ranged up to 0.2 MFL. The maximum total LA water concentration measured under high flow conditions was 1 MFL. For the purposes of these calculations, it was conservatively assumed that the total LA concentration in the water (C_{water}) applied was 1 MFL (1,000,000 s/L).

Based on discussions with the construction team, the best estimate of the water application rate (WR) during restoration activities by the removal contractor is about 0.5 gallons per square foot (gal/ft^2) in the soil application area. For the purposes of these calculations, the soil application area (A) was assumed to be 5,000 ft^2.

The mass of soil to which the water is applied (M_{soil}) is calculated as follows:

$$M_{soil} = A \cdot D \cdot \sigma \cdot CF_2$$

where:

A = Soil application area (ft^2)
D = Depth of water application (ft)
σ = Soil density (g/cc)
CF_2 = Conversion factor (28,317; ft^3 to cc)

Based on discussions with the construction team, the depth of water application (D) during construction activities is assumed to be about 6 inches (0.5 ft). For the purposes of these calculations, the soil density (σ) was assumed to be 1.5 g/cc.

Using these equations and inputs, the soil concentration after water application is calculated as:

$$\begin{aligned} C_{soil,post} &= C_{soil,pre} + ([C_{water} \cdot WR \cdot CF_1 \cdot A] / [A \cdot D \cdot \sigma \cdot CF_2]) \\ &= 5E{+}05\ s/g + ([1{,}000{,}000 \cdot 0.5 \cdot 3.8 \cdot 5{,}000] / [5{,}000 \cdot 0.5 \cdot 1.5 \cdot 28{,}317]) \\ &= 5E{+}05\ s/g + (9.5E{+}09\ s / 1.1E{+}08\ g) \\ &= 5E{+}05\ s/g + 89\ s/g = 5.00089E{+}05\ s/g \end{aligned}$$

As shown, construction use of water with total LA concentrations of 1 MFL would result in a minimal increase the LA soil concentration expressed as s/g. The difference in soil concentration on a mass percent basis would not be discernable based on current analytical methods for soil.

IRRIGATION SCENARIO

Because application during construction represents a short-term application scenario, screening level calculations were also performed to evaluate the effects of water use for a long-term irrigation scenario. The basic equations and assumptions utilized to evaluate the irrigation scenario are similar to those used to evaluate water application during construction, except that the number of structures added to the soil due to irrigation (N_{added}) includes a temporal component as follows:

$$N_{added} = C_{water} \cdot WR \cdot CF_1 \cdot A \cdot IF \cdot ID$$

where:

N_{added} = Number of LA structures added to soil due to irrigation (s)
C_{water} = Concentration of total LA in water (s/L)

WR = Water irrigation rate (gal/ft^2-day)
CF_1 = Conversion factor (3.8; gal to L)
A = Soil application area (ft^2)
IF = Irrigation frequency (days/year)
ID = Irrigation duration (years)

The water irrigation rate (WR) was assumed to be 1 inch of water per irrigation day, where 1 inch of water is equal to 624 gallons per 1,000 ft^2 (0.624 gal/ft^2-day). For the purposes of these calculations, it was assumed that irrigation was performed 3 times per week for 6 months of the year (i.e., 72 days/year) for a period of 50 years.

Using these above equations and inputs, the soil concentration after irrigation is calculated as:

$$\begin{aligned} C_{soil,post} &= C_{soil;pre} + ([C_{water} \cdot WR \cdot CF_1 \cdot A \cdot IF \cdot ID] / [A \cdot D \cdot \sigma \cdot CF_2]) \\ &= 5E{+}05\ s/g + ([1{,}000{,}000 \cdot 0.624 \cdot 3.8 \cdot 5{,}000 \cdot 72 \cdot 50] / [5{,}000 \cdot 0.5 \cdot 1.5 \cdot 28{,}317]) \\ &= 5E{+}05\ s/g + (4.3E{+}13\ s / 1.1E{+}08\ g) \\ &= 5E{+}05\ s/g + 4.0E{+}05\ s/g = 9.0E{+}05\ s/g \end{aligned}$$

As shown, construction use of water with total LA concentrations of 1 MFL would increase the LA soil concentration by a factor of about 1.8. The post-irrigation soil concentration would be approximately 0.025% by mass (as derived using the regression in Januch *et al.* 2013), which is well below the detection limit of soil analysis methods using polarized light microscopy (PLM) (i.e., these soils would be ranked as non-detect by PLM).

REFERENCES

Januch, J., W. Brattin, L. Woodbury, and D. Berry. 2013. Evaluation of a fluidized bed asbestos segregator preparation method for the analysis of low-levels of asbestos in soil and other solid media. *Analytical Methods* [advance article DOI: 10.1039/C3AY26254E] <http://pubs.rsc.org/en/Content/ArticleLanding/2013/AY/C3AY26254E>